REF 1

引例 1

(19)日本国特許庁（ＪＰ）　(12)公開特許公報（Ａ）　(11)特許出願公開番号

特開平10－36911

(43)公開日　平成10年(1998)２月10日

(51)Int.Cl.[6]		識別記号	庁内整理番号	ＦＩ		技術表示箇所
Ｃ２１Ｄ	8/00		9270－4K	Ｃ２１Ｄ	8/00	Ｅ
Ｂ２１Ｂ	3/02			Ｂ２１Ｂ	3/02	
Ｃ２２Ｃ	38/00	３０２		Ｃ２２Ｃ	38/00	３０２Ｚ
	38/50				38/50	
	38/54				38/54	

審査請求　未請求　請求項の数２　ＯＬ　（全６頁）

(21)出願番号　特願平8－193759

(22)出願日　平成８年(1996)７月23日

(71)出願人　000006655
新日本製鐵株式会社
東京都千代田区大手町２丁目６番３号

(72)発明者　阿部　雅之
千葉県富津市新富20－１　新日本製鐵株式会社技術開発本部内

(72)発明者　木村　醸
千葉県富津市新富20－１　新日本製鐵株式会社技術開発本部内

(72)発明者　瀬沼　武秀
千葉県富津市新富20－１　新日本製鐵株式会社技術開発本部内

(74)代理人　弁理士　田村　弘明

(54)【発明の名称】　表面特性に優れたフェライト系ステンレス鋼の製造方法

(57)【要約】　（修正有）

【課題】　冷延時に発生する微小うねり（ローピング）が小さく表面特性に優れたフェライト系ステンレス鋼薄板。

【解決手段】　重量%で、Ｃ：０．０２５～０．０５５、Ｎ：０．００１～０．０１５、Ｃｒ：１５．０～１８．０、Ｔｉ：０．００５～０．１０、Ｍｎ：０．０１～１．０、Ｓｉ：０．０１～１．０、Ａｌ：０．０１５～０．０２５を含有し、以下、いずれも、Ｓ：０．０１０、Ｐ：０．０４、Ｎｉ：０．５、Ｃｕ：０．５、Ｍｏ：０．２、Ｏ：０．０１０以下で、残部がＦｅ及び不可避的不純物からなり、γｐ＝４２０×Ｃ＋４７０×Ｎ＋２３×Ｎｉ＋１２×Ｃｕ＋７×Ｍｎ－１１．５×Ｃｒ－１１．５×Ｓｉ－１１×Ｍｏ－５２×Ａｌ－４９×Ｔｉ＋１８９のγｐが２０～３５%のフェライト系ステンレス鋼を１１５０～１３００℃で熱間圧延し、粗圧延で１１００℃以上での累積圧下率を４０%以上とし、引き続き仕上げ圧延を実施して捲取温度を４５０～６００℃とし、以後熱延板焼鈍を実施せず酸洗し冷延、最終焼鈍を実施する。

PATENT ABSTRACTS OF JAPAN

(11)Publication number : 10-036911
(43)Date of publication of application : 10.02.1998

(51)Int.Cl. C21D 8/00
B21B 3/02
C22C 38/00
C22C 38/50
C22C 38/54

(21)Application number : 08-193759
(22)Date of filing : 23.07.1996

(71)Applicant : NIPPON STEEL CORP
(72)Inventor : ABE MASAYUKI
KIMURA KEN
SENUMA TAKEHIDE

(54) PRODUCTION OF FERRITIC STAINLESS STEEL EXCELLENT IN SURFACE CHARACTERISTIC

(57)Abstract:
PROBLEM TO BE SOLVED: To prepare a ferritic stainless steel sheet minimal in minute waviness (roping) occurring at the time of cold rolling and excellent in surface characteristic. SOLUTION: A ferritic stainless steel, having a composition which consists of, by weight, 0.025-0.055% C, 0.001-0.015% N, 15.0-18.0% Cr, 0.005-0.10% Ti, 0.01-1.0% Mn, 0.01-1.0% Si, 0.015-0.025% Al, ≤0.010% S, ≤0.04% P, ≤0.5% Ni, ≤0.5% Cu, ≤0.2% Mo, ≤0.010% O, and the balance Fe with inevitable impurities and in which γp, represented by $\gamma p=420 \times C+470 \times N+23 \times Ni+12 \times Cu+7 \times Mn-11.5 \times Cr-11.5 \times Si-11 \times Mo-52 \times Al-49 \times Ti+189$, is regulated to 20-35%, is used. This steel is hot-rolled at 1150-1300° C, and cumulative draft at ≥1100° C at the time of roughing is regulated to ≥40%, and successively finish rolling is performed. The resultant steel plate is coiled at 450-600° C coiling temp. and subjected, without hot rolled plate annealing, to pickling, to cold rolling, and then to final annealing.

LEGAL STATUS

[Date of request for examination]	29.03.2002
[Date of sending the examiner's decision of rejection]	
[Kind of final disposal of application other than the examiner's decision of rejection or application converted registration]	
[Date of final disposal for application]	
[Patent number]	3806186
[Date of registration]	19.05.2006
[Number of appeal against examiner's decision of rejection]	
[Date of requesting appeal against examiner's decision of rejection]	
[Date of extinction of right]	

* NOTICES *

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to the manufacture approach of ferritic-stainless-steel sheet metal that the minute external waviness (roping) generated at the time of cold-rolling was small excellent in the surface characteristic, in the manufacture process of ferritic stainless steel.
[0002]
[Description of the Prior Art] Since nickel content is a low price few compared with austenitic stainless steel, ferritic stainless steel begins a kitchen instrument etc. and is used widely. In this case, since beautiful [surface] is needed, ferritic stainless steel is required to raise a surface characteristic.
[0003] However, it is known that the surface irregularity called RIJINGU as a product at the time of fabrication will tend to generate ferritic stainless steel. This RIJINGU is the irregularity of 5-50-micrometer height generated at the time of processing. The generating mechanism is also examined as the method of improving RIJINGU of ferritic stainless steel is examined variously conventionally, for example, it is described to steel 76(1990) P.1520 as iron.
[0004] As surface discontinuity, above-mentioned RIJINGU has so far been regarded as questionable. However, when cold-rolling of not the time of the fabrication of a product but the ferritic-stainless-steel hot-rolling plate is carried out, the minute wave generated on the front face of a cold-rolled plate cannot remain without even a final product disappearing, and it cannot be satisfied with recently of the surface grace searched for severely in recent years, and spoiling the value as a product poses a problem. This minute wave is a wave extended in height of 0.2 micrometers - about 0.5 micrometers on the front face of a cold-rolled plate in the rolling direction, and this wave is called roping in distinction from RIJINGU generated at the time of the fabrication of a product.
[0005] Moreover, the actual condition is inferior to SUS304 which is the representation steel type of austenitic stainless steel in respect of manufacturability -- SUS430 steel which is the typical steel type of ferritic stainless steel needs box annealing which needs dozens of hours after hot-rolling. Although many continuous-annealing-ized techniques of hot-rolling plate annealing and hot-rolling plate annealing abbreviation processes are also examined in order to simplify the manufacture process of SUS430 from such a viewpoint It is the component system which is characterized by the high pure flight system and high aluminum of low C, the reduction in N, and a raise in Ti in [system / of SUS430 usual steel / component] both cases, and is not established by the component system based on usual low Ti and low aluminum.
[0006]
[Problem(s) to be Solved by the Invention] Although roping was considered as the same phenomenon as RIJINGU until now It cannot be said that it is in RIJINGU generating at the time of fabrication, and generating of roping at the time of cold rolling about not necessarily good correspondence. Since cold-rolled rolling reduction becomes so small that it becomes high and, as for roping height, the generating mechanism of roping -- RIJINGU differs from generating behavior -- is not clear to the height becoming large, either, if, especially as for RIJINGU, working ratio becomes high, It is necessary to establish the

manufacture approach that roping can be reduced.
[0007] If roping generating can be reduced in the hot-rolling plate annealing abbreviation process that adding a new process to a process conventionally for roping reduction had large possibility of losing the merit of cheap ferritic stainless steel, and process saving progressed most, the ferritic stainless steel excellent in the surface characteristic can be offered still more cheaply. Therefore, the purpose of the invention in this application has generating of roping in offering the approach of manufacturing the ferritic stainless steel excellent in few surface characteristics, without making a process increase.
[0008]
[Means for Solving the Problem] this invention person etc. examined various methods of reducing roping in the manufacture process which omitted hot-rolling plate annealing of ferritic stainless steel. Consequently, the knowledge of the ability to reduce roping also in the process which omitted hot-rolling plate annealing was carried out by controlling a series of process conditions of a component, heating conditions, hot-rolling conditions, and **** conditions consistently.
[0009] The invention in this application is not based on independent control of a component or hot-rolling conditions, and needs the configuration which controls a series of following process conditions.
[0010] That is, the invention in this application is weight %. C : 0.025 - 0.055%, N : 0.001 - 0.015% Cr:15.0-18.0% S : 0.010% or less P : 0.04% or less, Ti: 0.005-0.10% Mn:0.01-1.0%, Si: 0.01-1.0% Less than [nickel:0.5%], Cu: Less than [0.5%] Less than [Mo:0.2%], aluminum: 0.015-0.025% O : 0.010% or less, Furthermore, B:0.005% or less and V:0.05% or less of one or more sorts are contained if needed. gammap shown by the bottom formula by the remainder consisting of Fe and an unescapable impurity The ferritic stainless steel which is 20 - 35% On the occasion of hot rolling, make whenever [stoving temperature] into 1150 degrees C or more 1300 degrees C or less, and accumulation rolling reduction in 1100 degrees C or more is made into 40% or more in rough rolling. It is the manufacture approach of ferritic stainless steel excellent in the surface characteristic characterized by carrying out acid washing and carrying out cold-rolling and the last annealing, without carrying out finishing rolling succeedingly, making **** temperature into 450-600 degrees C, and carrying out hot-rolling plate annealing henceforth.
gammap =420xC+470xN+23xnickel+12xCu+7xMn-11.5xCr-11.5xSi-11xMo-52xaluminum-49xTi+189
[0011]
[Embodiment of the Invention] Hereafter, the gestalt of operation of this invention is explained. this invention person etc. conducted the experiment aiming at reduction of roping generated at the time of cold-rolling of ferritic stainless steel, and examined the experimental result in the detail. Consequently, in order to have omitted hot-rolling plate annealing and to have improved roping, it became clear that it is important to promote the gamma-phase distribution in the middle of hot-rolling. It is being in the middle of hot-rolling, and making it deposit rather than depositing gamma-phase [in this case] at the time of heating, and it became clear that roping was improved by being able to attain decentralization more and making a gamma-phase amount into 15% or more.
[0012] Therefore, a component system which is as a component in the middle of hot-rolling, and gamma-phase deposits or increases was good, and that roping cannot improve became whether to be ** by component system by which a gamma-phase volume fraction decreases during rough hot-rolling. Roping is improvable if the accumulation rolling reduction in 1100 degrees C or more exceeds 40% at 15% or more as an amount of gamma under rough hot-rolling. Moreover, by component system by which gamma-phase decreases to 15% or less during rough hot-rolling, although it becomes easy to produce recrystallization during hot-rolling, when recrystallization arose, it also became clear that it was not admitted that roping height decreases remarkably.
[0013] It is gammap which it is required to adjust from the above-mentioned viewpoint so that the amount of gamma may become 15% or more during rough hot-rolling as a component, and is shown by the bottom formula as this amount of gamma. When there was 20% or more, that the amount required during rough rolling of gamma is also securable became whether to be **.
gammap =420xC+470xN+23xnickel+12xCu+7xMn-11.5xCr-11.5xSi-11xMo-52xaluminum-49xTi+189
[0014] Moreover, gammap It is related and is gammap. It is gammap, although roping improves so that

it is high. When it prescribes that a component exceeds 35, in the hot-rolling plate annealing abbreviation process of the invention in this application It is gammap in order that a bad influence may come out with the lug crack at the time of cold-rolling, and manufacturability other than a surface characteristic -- check the grain growth at the time of annealing, without gamma-phase disappearing only by annealing after cold-rolling while cold-rolling nature gets worse again, and reinforcement becomes high, and workability falls -- and the quality of the material. It could be 35% or less.
[0015] If whenever [stoving temperature] is set up as heating conditions so that a gamma-phase amount may serve as max at the time of heating, it is disadvantageous in respect of a gamma-phase activity, and it is important to set up whenever [stoving temperature] so that gamma-phase may deposit or increase during rough rolling. gammap gamma-phase is in the middle of hot-rolling, and it is made for at least 20% or more not to decrease -- being alike -- at the time of heating, it is required to make it the temperature to which gamma-phase decreases to some extent rather, and if it takes into consideration taking 40% or more of accumulation draft above 1100 degrees C, 1150 degrees C or more are required as whenever [stoving temperature]. However, since the surface section would cause abnormality grain growth by decarbonization and would cause a crack if it heats exceeding 1300 degrees C, the upper limit of whenever [stoving temperature] was made into 1300 degrees C.
[0016] It is satisfied with the above-mentioned viewpoint of a component and heating conditions, the relation between gamma-phase and hot-rolling conditions is making accumulation rolling reduction in 1100 degrees C or more into 40% or more, and it became clear that roping at the time of cold-rolling could be reduced. Making rolling reduction in 1100 degrees C or more into 40% or more, because it was required in order to make it distribute minutely after processing gamma-phase, it is because gamma deposit to a grain boundary serves as a subject in less than [this]. Moreover, it is gammap even if accumulation rolling reduction can secure 40%. Gamma-phase distribution becomes less uniform at less than 20%, although it is so desirable that the rolling reduction per one pass is high, even if it divides into number pass and carries out about rolling of 1100 degrees C or more with which a big and rough grain remains to a hot-rolling plate, and makes roping poor, it is effective, and about finish rolling, high-speed rolling-elevated-temperature finishing is desirable.
[0017] **** temperature after hot-rolling is made into an elevated temperature from 450 degrees C below 600 degrees C. From 600 degrees C, at an elevated temperature, gamma-phase decomposes into a ferrite and carbide and the improvement inclination of roping decreases. Moreover, since ferrite grain growth will be checked by the time martensite carries out a reverse transformation at the time of heat treatment after cold-rolling and the yield point becomes high, when premised on the process which metamorphosed into martensite at low temperature 450 degrees C or less, and was made to distribute gamma-phase minutely like the invention in this application, and omitted hot-rolling plate annealing, although remarkable low-temperature **** improves a roping property, in order to make the quality of the material hard, the minimum of **** temperature was taken as the temperature exceeding 450 degrees C.
[0018] As a result of examining the component range, and the above-mentioned roping reduction approach With weight % C : 0.025 - 0.055%, N : 0.001 - 0.015% Cr:15.0-18.0% S : 0.010% or less P : 0.04% or less, Ti: 0.005-0.10% Mn:0.01-1.0%, Si: 0.01-1.0% Less than [nickel:0.5%], Cu: Less than [0.5%] Less than [Mo:0.2%], aluminum: 0.015-0.025% O : 0.010% or less, B:0.005% or less and V:0.05% or less of one or more sorts were contained further if needed, and it became clear that it was realized in the ferritic stainless steel with which the remainder consists of Fe and an unescapable impurity. .
[0019] The reason for limitation of a component is explained below.
C: C is especially harmful in respect of corrosion resistance, and although it has a bad influence on the corrosion resistance of a weld zone, in order to secure reinforcement and a gamma-phase amount proper, a certain extent is required. Since workability and ductility would deteriorate if the amounts of gamma run short at less than 0.025%, and a ferrite grain makes it big and rough from a gamma-phase viewpoint and it adds exceeding 0.055%, C could be 0.025 - 0.055%.
[0020] N: Since it will become high intensity and workability will deteriorate if ****** is industrially

difficult for less than 0.001% and it adds exceeding 0.015%, although corrosion resistance and workability of N are so desirable that there are few contents like C, add N in 0.001 - 0.015% of range.
[0021] Cr:Cr is the main element of the ferritic stainless steel of the invention in this application, and in order to secure corrosion resistance, it is necessary to add it 15% or more. However, even if it added exceeding 18%, feeding habits improved, but since C for securing the amount of gamma, N, and the amount of Mn increased and workability and toughness changed, the upper limit of Cr was made into 18%.
[0022] S: S degrades ductility, toughness, etc., and also from a corrosion resistance viewpoint, since it is harmful, it may be 0.010% or less.
P: P is harmful also workability, toughness, and in respect of corrosion resistance, and make the content into 0.040% or less so desirably that it is few.
[0023] Ti: It is an element required since N is fixed from a viewpoint of workability in the invention in this application, and add 0.005% or more. However, when it adds superfluously, an upper limit -- the need that they add gamma stabilization element so much since the fixed effects of N are that the improving thing price becomes high and a ferrite formation element with powerful Ti itself arises -- is 0.1% or less. It is desirable to consider as 0.05% or less from a viewpoint of roping.
[0024] Although Mn:Mn is added as a deoxidation element, since the effectiveness is saturated with less than 0.01% even if effectiveness adds exceeding 1% rather than is enough, it adds at 0.01 - 1.0%.
[0025] Since Si:Si will promote embrittlement remarkably and will degrade ductility and toughness if there is no effectiveness sufficient at less than 0.01% and it adds exceeding 1%, although used as a deoxidizer, it is added at 0.01 - 1.0%.
[0026] nickel:nickel can be used as a gamma-phase stabilization element. However, since gamma-phase cannot decompose during subsequent heat treatment since gamma-phase will be remarkably stable if it adds so much, but workability deteriorates, it adds at 0.5% or less.
Cu:Cu can be used as a gamma-phase stabilization element. However, since reinforcement will rise remarkably by Cu if it adds so much, it adds at 0.5% or less.
Mo:Mo can be used as a ferrite phase stabilization element. However, since reinforcement will rise and workability will deteriorate if it adds so much, it is used at 0.2% or less.
[0027] It is required to consider as 0.015% or more which aluminum:aluminum is used as a deoxidation element and can be used also for immobilization of N. Moreover, aluminum was a powerful ferrite stabilization element, and if it is made to contain so much, in order to decrease the amount of gamma, it could be 0.025% or less.
O: Since O degraded the toughness of a hot-rolling plate or caused nozzle plugging at the time of casting, crack generating, and toughness degradation of a hot-rolling plate, it could be 0.01% or less in the invention in this application.
[0028] One or more sorts of B and V can be made to contain if needed in this invention.
B: Since B fixes N, it can improve workability. However, even if it added superfluously, since the effectiveness was saturated, it was made into 0.005% or less.
V:V fixes C and N, and since it can improve workability, it can add them at 0.05% or less as a selection element.
[0029]
[Example] The ferritic stainless steel of the component shown in Table 1 was ingoted by the vacuum melting of a lab, and 50kg steel ingot with a thickness of 100mm was manufactured. Then, rough rolling was carried out to 20mm with five pass after heating on the conditions shown in Table 2, finish hot-rolling was carried out with six pass from 20mm to 5-3mm, that ******** was inserted in the 750-350-degree C furnace, carried out after [the 1 hour retention] furnace cooling, and **** was simulated. The **** temperature of front Naka is the retention temperature of this simulation. Then, cold-rolling of the rate of cold rolling was changed and carried out to the thickness of 2.0-0.4mm after acid washing with the sulfuric acid, and roping height was evaluated.
[0030] Roping performed cold-rolling to 0.4mm after acid washing, measured the above-mentioned hot-rolling plate with the roughness plan about 10mm length in the direction of a right angle to the direction

of cold-rolling, and made it roping height with the maximum of external waviness height. Three places of this measurement were carried out and that average estimated roping. The average of the roping maximum height whose evaluation is three places evaluated A ranks and 0.15 micrometers or more less than 0.25 micrometers for less than 0.15 micrometers, and evaluated C rank and 0.35 micrometers or more for B ranks and 0.25 micrometers or more - less than 0.35 micrometers as a D rank. If it is A and B ranks, it will not become a problem from the point of surface grace. As shown in Table 2, each invention-in-this-application material had roping height as small as less than 0.25 micrometers, and showed the outstanding surface characteristic.

[0031]

[Table 1]

No.	成分（wt%）														ΔP
	C	Si	Mn	P	S	Cr	Ni	Cu	Mo	Al	Ti	O	N	その他	
A	0.039	0.30	0.76	0.025	0.0046	16.51	0.10	0.05	0.02	0.020	0.012	0.0033	0.0071		22.3
B	0.051	0.41	0.86	0.019	0.0054	16.08	0.09	0.02	0.09	0.022	0.074	0.0045	0.0069		26.6
C	0.048	0.22	0.80	0.027	0.0072	16.31	0.16	0.17	0.02	0.020	0.009	0.0022	0.0128		34.7
D	0.054	0.26	0.87	0.024	0.0048	17.05	0.04	0.01	0.03	0.024	0.037	0.0026	0.0101	B:0.0043	21.1
E	0.048	0.33	0.66	0.031	0.0056	16.27	0.15	0.05	0.04	0.021	0.022	0.0041	0.0145		31.1
F	0.035	0.14	0.78	0.030	0.0049	16.68	0.16	0.14	0.06	0.024	0.069	0.0037	0.0109		20.9
G	0.043	0.35	0.31	0.017	0.0043	16.45	0.11	0.12	0.10	0.018	0.045	0.0029	0.0097	V:0.025	20.3
H	0.053	0.48	0.89	0.020	0.0033	17.02	0.21	0.16	0.04	0.020	0.015	0.0044	0.0142	B:0.0024 V:0.020	27.4
I	0.036	0.28	0.44	0.029	0.0060	16.03	0.15	0.24	0.06	0.023	0.008	0.0036	0.0108	V:0.042	28.8
J	0.044	0.29	0.18	0.022	0.0051	16.11	0.07	0.01	0.07	0.017	0.020	0.0030	0.0083		23.1
K	0.054	0.20	0.20	0.033	0.0068	16.65	0.05	0.03	0.02	0.024	0.009	0.0045	0.0093		23.3
L	0.075	0.34	0.30	0.032	0.0066	16.26	0.12	0.06	0.11	0.025	0.021	0.0040	0.0250		43.4
M	0.020	0.30	0.75	0.025	0.0038	16.30	0.05	0.04	0.09	0.023	0.018	0.0041	0.0090		14.5
N	0.035	0.29	0.83	0.024	0.0036	16.59	0.09	0.07	0.05	0.020	0.010	0.0037	0.0117		21.7
O	0.043	0.32	0.56	0.022	0.0075	16.22	0.15	0.08	0.06	0.017	0.008	0.0046	0.0124		26.0
P	0.051	0.46	0.15	0.026	0.0049	16.43	0.09	0.02	0.04	0.019	0.040	0.0033	0.0098		20.8
Q	0.052	0.24	0.80	0.037	0.0078	16.18	0.06	0.03	0.03	0.024	0.017	0.0034	0.0087		31.0

＊下線は本願の条件から外れていることを示す。

ローピング評価基準…A:0.15μm未満、B:0.15～0.25μm未満、C:0.25～0.35μm未満、D:0.35μm以上

[0032]

[Table 2]

No.	加熱温度 (℃)	熱延				冷延		備考
		粗圧延		仕上圧延終了温度 (℃)	捲取温度 (℃)	圧下率 (%)	ローピング評点	
		1100℃以上累積圧下率(%)	粗仕上げ温度 (℃)					
A	1250	70	1068	940	475	70	A	本発明例
B	1180	50	1015	925	550	87	B	本発明例
C	1230	40	1034	865	500	80	B	本発明例
D	1180	40	1065	870	500	65	B	本発明例
E	1250	40	1075	912	500	55	B	本発明例
F	1220	70	1060	887	475	73	A	本発明例
G	1180	60	1027	931	575	80	A	本発明例
H	1180	40	1034	894	510	80	B	本発明例
I	1250	70	1087	840	475	70	A	本発明例
J	1150	45	1002	869	600	87	B	本発明例
K	1150	50	1011	874	500	70	A	本発明例
L	1200	45	1018	869	550	80	B	比較例(耳割れ)
M	1180	50	1032	874	500	70	D	比較例
N	1150	30	963	861	600	70	D	比較例
O	1100	0	898	832	500	70	D	比較例
P	1150	40	994	850	750	87	C	比較例
Q	1150	50	1012	849	350	70	D	比較例

[0033]
[Effect of the Invention] As mentioned above, this invention can reduce roping at the time of cold-rolling which is the trouble of the surface characteristic of ferritic stainless steel in a hot-rolling plate annealing abbreviation process, and contributes to an improvement of a surface characteristic by low cost.

[Translation done.]

1

【特許請求の範囲】

【請求項１】重量%で、

Ｃ　：０．０２５～０．０５５%、

Ｎ　：０．００１～０．０１５%、

Ｃｒ：１５．０～１８．０%、

Ｓ　：０．０１０%以下.

Ｐ　：０．０４%以下、

Ｔｉ：０．００５～０．１０%、

Ｍｎ：０．０１～１．０%.

Ｓｉ：０．０１～１．０%.

Ｎｉ：０．５%以下、

Ｃｕ：０．５%以下、

Ｍｏ：０．２%以下、

Ａｌ：０．０１５～０．０２５%、

Ｏ　：０．０１０%以下

を含有し、残部がＦｅ及び不可避的不純物からなり、下式で示されるγｐが２０～３５%であるフェライト系ステンレス鋼を．熱間圧延に際し加熱温度を１１５０℃以上１３００℃以下にし、粗圧延において１１００℃以上での累積圧下率を４０%以上とし、引き続き仕上げ圧延を実施して巻取温度を４５０～６００℃とし、以後熱延板焼鈍を実施することなく酸洗し冷延．最終焼鈍を実施することを特徴とする表面特性に優れたフェライト系ステンレス鋼の製造方法。

γｐ＝４２０×Ｃ＋４７０×Ｎ＋２３×Ｎｂ＋１２×Ｃｕ＋７×Ｍｎ－１１．５×Ｃｒ－１１．５×Ｓｉ－１１×Ｍｏ－５２×Ａｌ－４９×Ｔｉ＋１８９

【請求項２】重量%で、

Ｃ　：０．０２５～０．０５５%、

Ｎ　：０．００１～０．０１５%、

Ｃｒ：１５．０～１８．０%、

Ｓ　：０．０１０%以下.

Ｐ　：０．０４%以下、

Ｔｉ：０．００５～０．１０%、

Ｍｎ：０．０１～１．０%.

Ｓｉ：０．０１～１．０%.

Ｎｉ：０．５%以下、

Ｃｕ：０．５%以下、

Ｍｏ：０．２%以下、

Ａｌ：０．０１５～０．０２５%.

2

小うねり（ローピング）が小さく表面特性に優れたフェライト系ステンレス鋼薄板の製造方法に関する。

【０００２】

【従来の技術】フェライト系ステンレス鋼はオーステナイト系ステンレス鋼に比べてＮｉ含有量が少ないためコストが安いであるため、厨房器具等をはじめ広く使用されている。この場合、表面の美麗さが必要となるため表面品位を向上させることがフェライト系ステンレス鋼の重要な課題となる。

【０００３】しかし、フェライト系ステンレス鋼は、製品として成形加工時にリジングと言われる表面凹凸が発生しやすいことが知られている。このリジングは成形加工時に発生する５～５０μｍ高さの凹凸であり、フェライト系ステンレス鋼のリジングを改善する方法について種々検討されており、例えば．鉄と鋼７６巻Ｐ．１５２０に述べられているように発生機構についても検討されている。

【０００４】これまで表面欠陥としては．リジングが問題視されてきた。しかしながら．リジングは成形加工時ではなく、フェライト系ステンレス鋼を冷延したときに冷延板の表面に発生するうねりが最終製品まで消えずに残り、近年厳しくなる表面品位を満足することができず．製品価値を損なうことが問題となっている。このうねりは冷延板の表面に高さ０．２μｍ～０．５μｍ圧延方向に伸びたうねりであり．このうねりは成形加工時に発生するリジングと区別してローピングと呼ばれている。

【０００５】またフェライト系ステンレス鋼の代表鋼種であるＳＵＳ４３０鋼は、熱延後に箱焼鈍を必要とするなど製造性の劣るフェライト系ステンレス鋼の代表鋼種であるＳＵＳ４３０が劣っているのが実状である。このようなＳＵＳ４３０の製造プロセスを簡略化するため連続焼鈍化技術や熱延板焼鈍省略プロセスが多く検討されているが、どちらの場合も通常のＳＵＳ４３０鋼の成分系よりは低Ｃ．低Ｎ化、高Ｔｉ添加フェライト系や高Ａｌを特徴とするような成分系、あるいは高の低Ｔｉ、低Ａｌを基本とする成分系が多くなっていない。

【０００７】ローピング低減のために従来工程に新工程を付加することは、安価なフェライト系ステンレス鋼のメリットを失う可能性が大きく、最も省工程が進んだ熱延板焼鈍省略プロセスでローピング発生を低減できれば、表面特性が優れたフェライト系ステンレス鋼をさらに安価に提供できることとなる。従って本願発明の目的は工程を増加させることなく、ローピングの発生が少ない表面特性に優れたフェライト系ステンレス鋼を製造する方法を提供することにある。

【０００８】

【課題を解決するための手段】本発明者等は、フェライ

＊ト系ステンレス鋼の熱延板焼鈍を省略し
においてローピングを低減する方法を種
の結果、成分、加熱条件、熱延条件、捲
プロセス条件を一貫して制御することで
省略したプロセスでもローピングを低減
見した。

【０００９】本願発明は、成分や熱延条
によるものではなく、以下の一連のプロ
する構成を必要とする。

【００１０】すなわち、本願発明は、重

Ｃ	：０．０２５～０．０５５％、	Ｎ	：０．００１～０．０１５％、
Ｃｒ	：１５．０～１８．０％、	Ｓ	：０．０１０％以下、
Ｐ	：０．０４％以下、	Ｔｉ	：０．００５～０．１０％、
Ｍｎ	：０．０１～１．０％、	Ｓｉ	：０．０１～１．０％、
Ｎｉ	：０．５％以下、	Ｃｕ	：０．５％以下、
Ｍｏ	：０．２％以下、	Ａｌ	：０．０１５～０．０２５％、
Ｏ	：０．０１０％以下、		

さらに必要に応じて、Ｂ：０．００５％以下、Ｖ：０．０５％以下の１種以上を含有し、残部がＦｅ及び不可避的不純物からなり、下式で示されるγｐが２０～３５％であるフェライト系ステンレス鋼を、熱間圧延に際し加熱温度を１１５０℃以上１３００℃以下にし、粗圧延において１１００℃以上での累積圧下率を４０％以上とし、引き続き仕上げ圧延を実施して捲取温度を４５０～６００℃とし、以後熱延板焼鈍を実施することなく酸洗し冷延、最終焼鈍を実施することを特徴とする表面特性に優れたフェライト系ステンレス鋼の製造方法である。

γｐ＝４２０×Ｃ＋４７０×Ｎ＋２３×Ｎｉ＋１２×Ｃｕ＋７×Ｍｎ－１１．５×Ｃｒ－１１．５×Ｓｉ－１１×Ｍｏ－５２×Ａｌ－４９×Ｔｉ＋１８９

【００１１】

【実施の形態】以下、本発明の実施の形態について説明する。本発明者等はフェライト系ステンレス鋼の冷延時に発生するローピングの低減を目的とした実験を行い、実験結果を詳細に検討した。その結果、熱延板焼鈍を省略してかつローピングを改善するには、熱延途中のγ相の分散を促進させることが重要であることが判明した。この際のγ相は加熱時に析出させるよりも、熱延途中で析出させることで、より分散化が図れ、またγ相量を１

ローピング高さが著しく減少することは
とも判明した。

【００１３】上記の観点から、成分とし
延中に１５％以上となるように調整する
り、このγ量としては下式で示されるγ
あれば、粗圧延中に必要なγ量が確保で
となった。

γｐ＝４２０×Ｃ＋４７０×Ｎ＋２３×
ｕ＋７×Ｍｎ－１１．５×Ｃｒ－１１．
×Ｍｏ－５２×Ａｌ－４９×Ｔｉ＋１８

【００１４】またγｐに関しては、γｐ：
ピングは改善されるがγｐが３５を超え
規定すると本願発明の熱延板焼鈍省略プ
延時の耳割れや、また冷延性が悪化する
の焼鈍のみではγ相が消えずに焼鈍時の
し、また強度が高くなり加工性が低下す
以外の製造性、材質で悪影響がでるため
以下とした。

【００１５】加熱条件としては、加熱時
となるように加熱温度を設定するとγ相
であり、粗圧延中にγ相が析出または増
熱温度を設定することが重要である。γ

できることが判明した。１１００℃以上での圧下率を４０%以上としたのは、γ相を加工後微細に分散させるために必要であるためであり、これ以下では粒界へのγ析出が主体となるためである。また累積圧下率が４０%を確保できても、γpが２０%未満ではγ相の分散が均一でなくなり粗大粒が熱延板に残存し、ローピングを不良とする１１００℃以上の圧延に関しては、１パスあたりの圧下率が高いほど好ましいが、数パスに分けて実施しても効果があり、また仕上圧延に関しては高速圧延－高温仕上げが望ましい。

【００１７】熱延後の巻取温度は６００℃以下で４５０℃より高温とする。６００℃より高温ではγ相がフェラ＊

＊イトと炭化物に分解してしまい、ローピが減少する。また４５０℃以下の低温でイトに変態してしまい、本願発明のように散させ、かつ熱延板焼鈍を省略したプロた場合、冷延後の熱処理時にマルテンサるまでにフェライト粒の成長を阻害し降ため、著しい低温巻取はローピング特性質を硬質にするため巻取温度の下限は４温度とした。

【００１８】そして、成分範囲について上記のローピング低減方法は、重量%で、

C　：0．025～0．055%．　N　：0．001～0．015%．
Cr：15．0～18．0%、　S　：0．010%以下、
P　：0．04%以下．　Ti：0．005～0．10%．
Mn：0．01～1．0%、　Si：0．01～1．0%、
Ni：0．5%以下、　Cu：0．5%以下．
Mo：0．2%以下、　Al：0．015～0．025%．
O　：0．010%以下．

さらに必要に応じて、B：0．005%以下、V：0．05%以下の１種以上を含有し、残部がFe及び不可避的不純物からなるフェライト系ステンレス鋼において成り立つことが判明した。。

【００１９】以下に成分の限定理由を述べる。

C：Cは耐食性の点では有害であり特に溶接部の耐食性に悪影響を与えるが、強度およびγ相量を適正に確保するためにはある程度は必要である。γ相の観点からは0．025%未満ではγ量が不足しフェライト粒が粗大化する、また0．055%を超えて添加すると加工性、延性が劣化するためにCは0．025～0．055%とした。

【００２０】N：NはCと同様に含有量が少ないほど耐食性．加工性が好ましいが0．001%未満にすることは工業的には困難であり、また0．015%を超えて添加すると高強度となり加工性が劣化するためにNは0．001～0．015%の範囲で添加する。

【００２１】Cr：Crは本願発明のフェライト系ステンレス鋼の主要元素であり、耐食性を確保するためには１５%以上添加する必要がある。しかし、１８%を超えて添加しても食性は向上するが、γ量を確保するための

以上添加する。しかし、過剰に添加するは向上するもの価格が高くなることや、なフェライト形成元素であるためγ安定添加する必要性が生じるなど上限は0．る。ローピングの観点からは0．05%とが望ましい。

【００２４】Mn：Mnは脱酸元素として0．01%未満では効果が十分ではなく、添加してもその効果が飽和するため0．で添加する。

【００２５】Si：Siは脱酸剤として0．01%未満では十分な効果がなく、て添加すると腐化を著しく促進させ延性せるので0．01～1．0%で添加する。

【００２６】Ni：Niはγ相安定化元きる。但し多量に添加するとγ相が著しめ、γ相がその後の熱処理中に分解できするため0．5%以下で添加する。

Cu：Cuはγ相安定化元素として使用量に添加するとCuによって強度が著し0．5%以下で添加する。

め．本願発明においては０．０１％以下，とした。

【００２８】本発明では必要に応じてＢ，Ｖの１種以上を含有させることができる。

Ｂ：ＢはＮを固定するため．加工性を改善することができる。しかし過剰に添加してもその効果は飽和するため．０．００５％以下とした。

Ｖ：ＶはＣやＮを固定し．加工性を改善できるため選択元素として０．０５％以下で添加できる。

【００２９】

【実施例】表１に示す成分のフェライト系ステンレス鋼をラボの真空溶解で溶製し．厚み１００㎜の５０kg鋼塊を製造した。この後、表２に示す条件で加熱後．粗圧延を５パスで２０㎜まで実施し、仕上熱延を２０㎜から５～３㎜まで６パスで実施し．そのき熱延板を７５０～３５０℃の炉に挿入し１時間保定後炉冷して巻取をシミュレートした。表中の巻取温度はこのシミュレートの保定温度である。この後、硫酸で酸洗後．厚み２．０～０．＊

＊４㎜まで冷間圧延率を変えて冷延し．ロ評価した。

【００３０】ローピングは．上記熱延板．４㎜まで冷延を行い、冷延方向に対して㎜長さについて粗度計で測定し、うねり待ってローピング高さとした。この測定し．その平均値でローピングを評価した所のローピング最大高さの平均が０．１ランク、０．１５μm以上０．２５μmク．０．２５μm以上～０．３５μm未０．３５μm以上をＤランクとして評価の点からはＡ、Ｂランクであれば問題とい。表２に示すように、本願発明材はいグ高さが０．２５μm未満と小さく．優示した。

【００３１】

【表１】

No.	成分（wt%）														7!
	C	Si	Mn	P	S	Cr	Ni	Cu	Mo	Al	Ti	O	N	その他	
A	0.039	0.30	0.76	0.025	0.0046	16.51	0.19	0.05	0.02	0.020	0.012	0.0033	0.0071		23
B	0.051	0.41	0.86	0.019	0.0054	16.08	0.09	0.02	0.09	0.022	0.074	0.0045	0.0069		26
C	0.048	0.22	0.80	0.027	0.0072	16.21	0.16	0.17	0.02	0.020	0.009	0.0022	0.0128		24
D	0.054	0.26	0.87	0.024	0.0048	17.05	0.04	0.01	0.03	0.024	0.037	0.0026	0.0101	B:0.0043	21
E	0.048	0.33	0.66	0.031	0.0056	16.27	0.15	0.05	0.04	0.021	0.028	0.0041	0.0145		31
F	0.035	0.14	0.78	0.030	0.0049	16.68	0.16	0.14	0.06	0.024	0.069	0.0087	0.0109		20
G	0.043	0.35	0.31	0.017	0.0043	16.45	0.11	0.12	0.10	0.018	0.045	0.0029	0.0097	V:0.025	20
H	0.053	0.48	0.89	0.020	0.0033	17.02	0.21	0.16	0.04	0.060	0.015	0.0044	0.0142	B:0.0024 V:0.020	27
I	0.036	0.28	0.44	0.029	0.0060	16.09	0.15	0.24	0.06	0.023	0.006	0.0086	0.0108	V:0.042	28
J	0.044	0.29	0.16	0.022	0.0051	16.11	0.07	0.01	0.07	0.017	0.020	0.0080	0.0088		23
K	0.054	0.20	0.20	0.038	0.0069	16.05	0.05	0.03	0.02	0.024	0.009	0.0045	0.0093		22
L	0.075	0.84	0.30	0.032	0.0056	16.26	0.12	0.09	0.11	0.025	0.021	0.0040	0.0250		48
M	0.020	0.30	0.75	0.025	0.0088	16.80	0.05	0.04	0.09	0.028	0.018	0.0041	0.0090		14
N	0.035	0.29	0.88	0.024	0.0086	16.59	0.08	0.07	0.05	0.020	0.010	0.0037	0.0117		21
O	0.043	0.82	0.56	0.022	0.0075	16.22	0.15	0.08	0.06	0.017	0.008	0.0046	0.0124		28
P	0.051	0.48	0.15	0.023	0.0049	16.43	0.09	0.02	0.04	0.019	0.040	0.0033	0.0068		20
Q	0.052	0.24	0.80	0.037	0.0078	16.18	0.05	0.03	0.08	0.024	0.017	0.0084	0.0087		31

＊下線は本願の条件から外れていることを示す。

ローピング評価基準…A:0.15μm未満、B:0.15～0.25μm未満、C:0.25～0.35μm未満、D:0.35μm以上

【００３２】

【表２】

No.	加熱温度 (℃)	熱延				冷延		備考
		粗圧延		仕上圧延終了温度 (℃)	巻取温度 (℃)	圧下率 (%)	ローピング評点	
		1100℃以上累積圧下率(%)	粗仕上げ温度 (℃)					
A	1250	70	1055	940	475	70	A	本発明例
B	1180	50	1015	925	550	87	B	本発明例
C	1230	40	1034	865	500	80	B	本発明例
D	1180	40	1065	870	500	65	B	本発明例
E	1250	40	1075	912	500	55	B	本発明例
F	1220	70	1060	887	475	75	A	本発明例
G	1180	60	1027	951	575	80	A	本発明例
H	1180	40	1034	894	510	50	D	本発明例
I	1250	70	1087	840	475	70	A	本発明例
J	1150	45	1002	869	600	87	B	本発明例
K	1150	50	1011	874	500	70	A	本発明例
L	1200	45	1013	869	550	80	B	比較例(巻取)
M	1180	50	1032	874	500	70	D	比較例
N	1150	20	983	851	800	70	D	比較例
O	1100	0	896	832	500	70	D	比較例
P	1150	40	894	850	750	87	C	比較例
Q	1150	60	1012	849	350	70	D	比較例

【００３３】

【発明の効果】上記のように、本発明はフェライト系ステンレス鋼の表面特性の問題点である冷延時のローピングを熱延板焼鈍省略プロセスにて低減で表面特性の改善に寄与する。